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Matsuyama

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(54) **DROPLET DISCHARGE METHOD AND DROPLET DISCHARGE DEVICE**

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B05D 5/06 (2006.01)

(52) **U.S. Cl.**
USPC **427/162**

(58) **Field of Classification Search**
USPC 427/162
See application file for complete search history.

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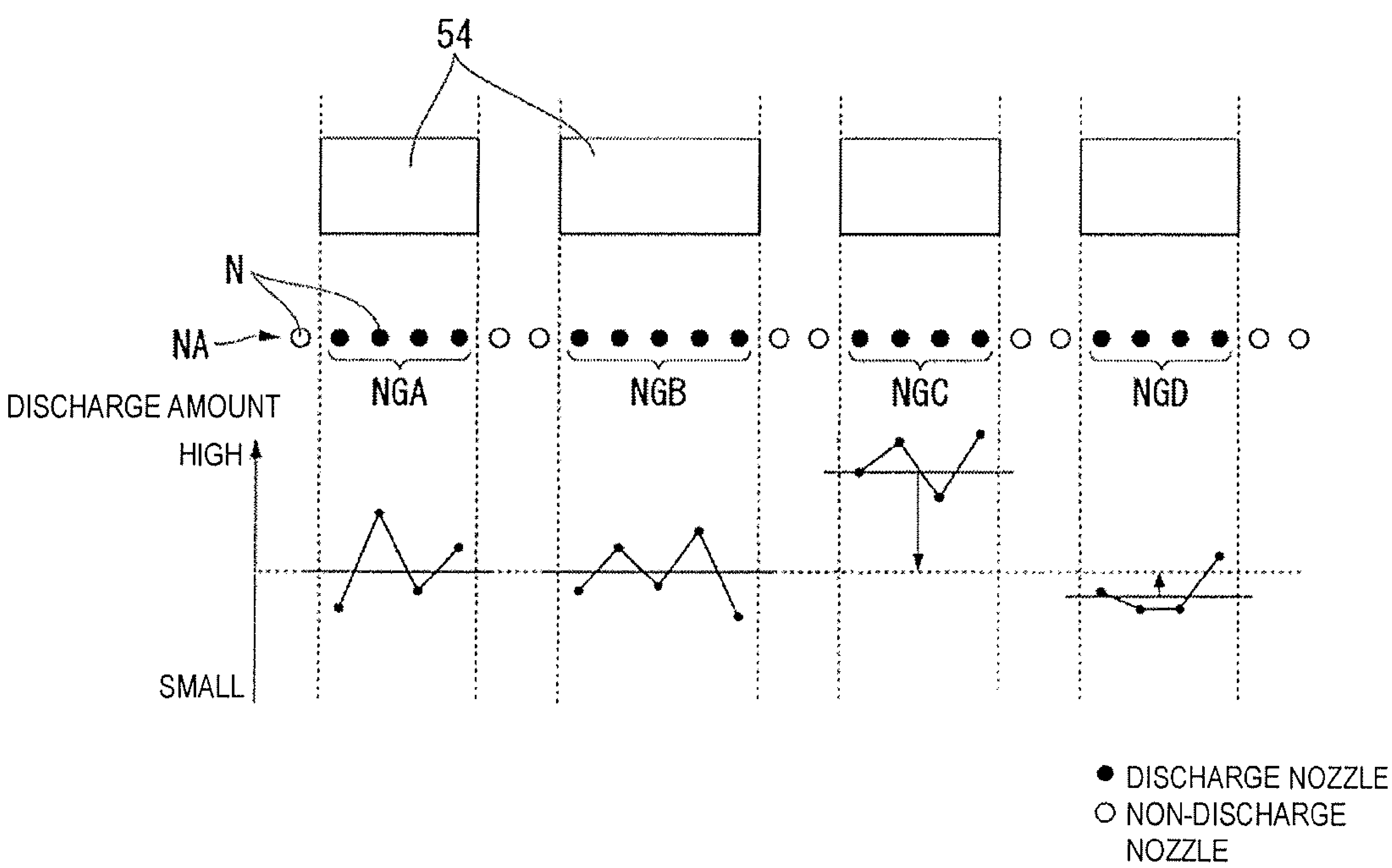
(57) **ABSTRACT**

A droplet discharge method is for discharging a liquid into a plurality of drawing regions partitioned on a substrate from a plurality of nozzles formed in a droplet discharge head while moving the droplet discharge head relative to the substrate. The droplet discharge method includes dividing the nozzles into a plurality of nozzle groups so that the nozzles in one of the nozzles groups face the same drawing region, correcting an amount of the liquid discharged from the nozzles so that an average value of an amount of the liquid discharged from the nozzles constituting the nozzle groups is substantially uniform among the nozzle groups, and discharging the liquid from the nozzles while the droplet discharge head is moved relative to the substrate.

3 Claims, 7 Drawing Sheets



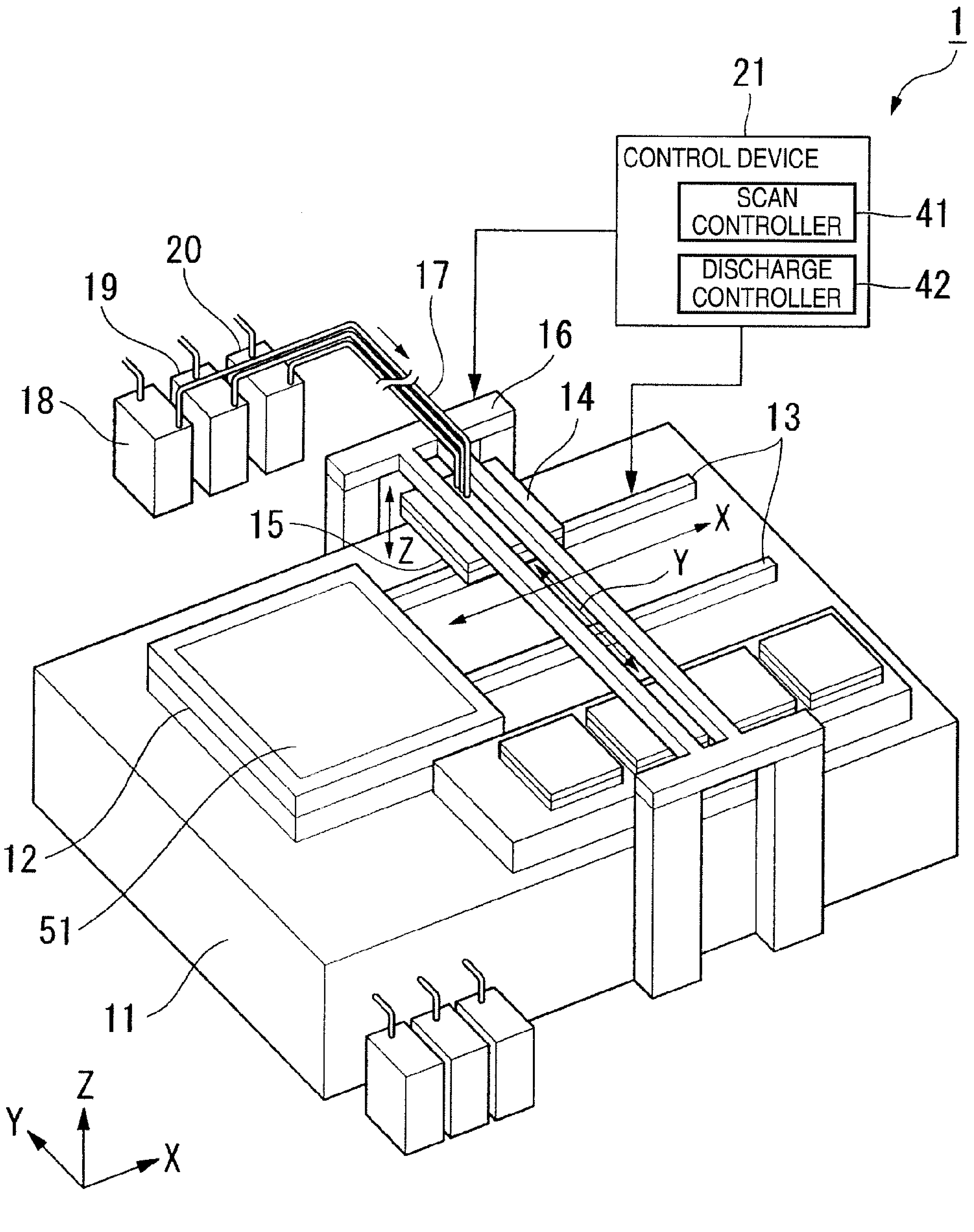
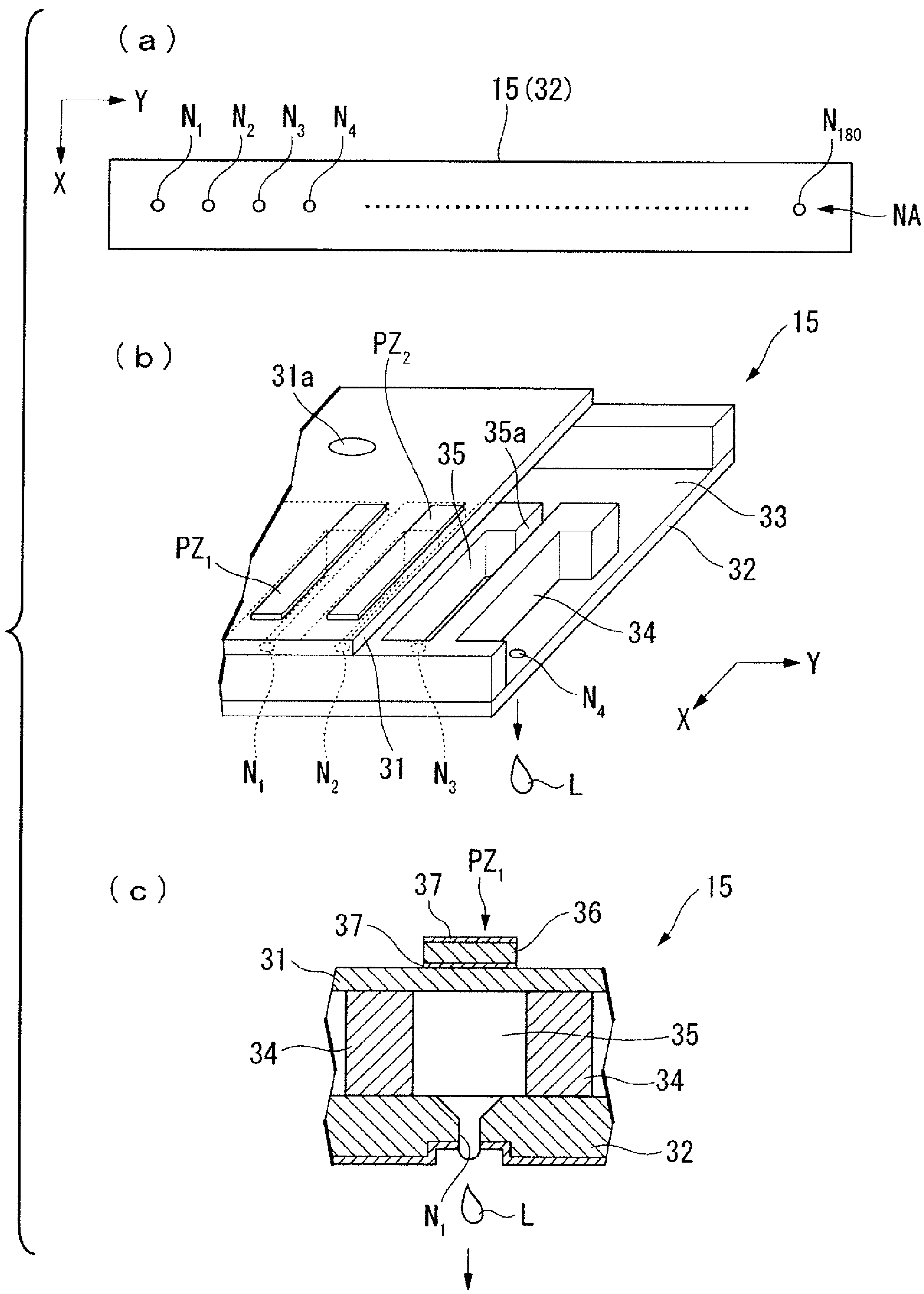

1
21
CONTROL DEVICE
SCAN CONTROLLER
41
DISCHARGE CONTROLLER
42
20
19
17
16
18
14
13
15
X
Z
Y
12
51
11
Y
Z
X

FIG. 1


(a)
15 (32)
Y
X
N1
N2
N3
N4
N180
NA
(b)
15
PZ2
31a
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35
33
PZ1
32
34
Y
N4
X
N1
N2
31
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(c)
PZ1
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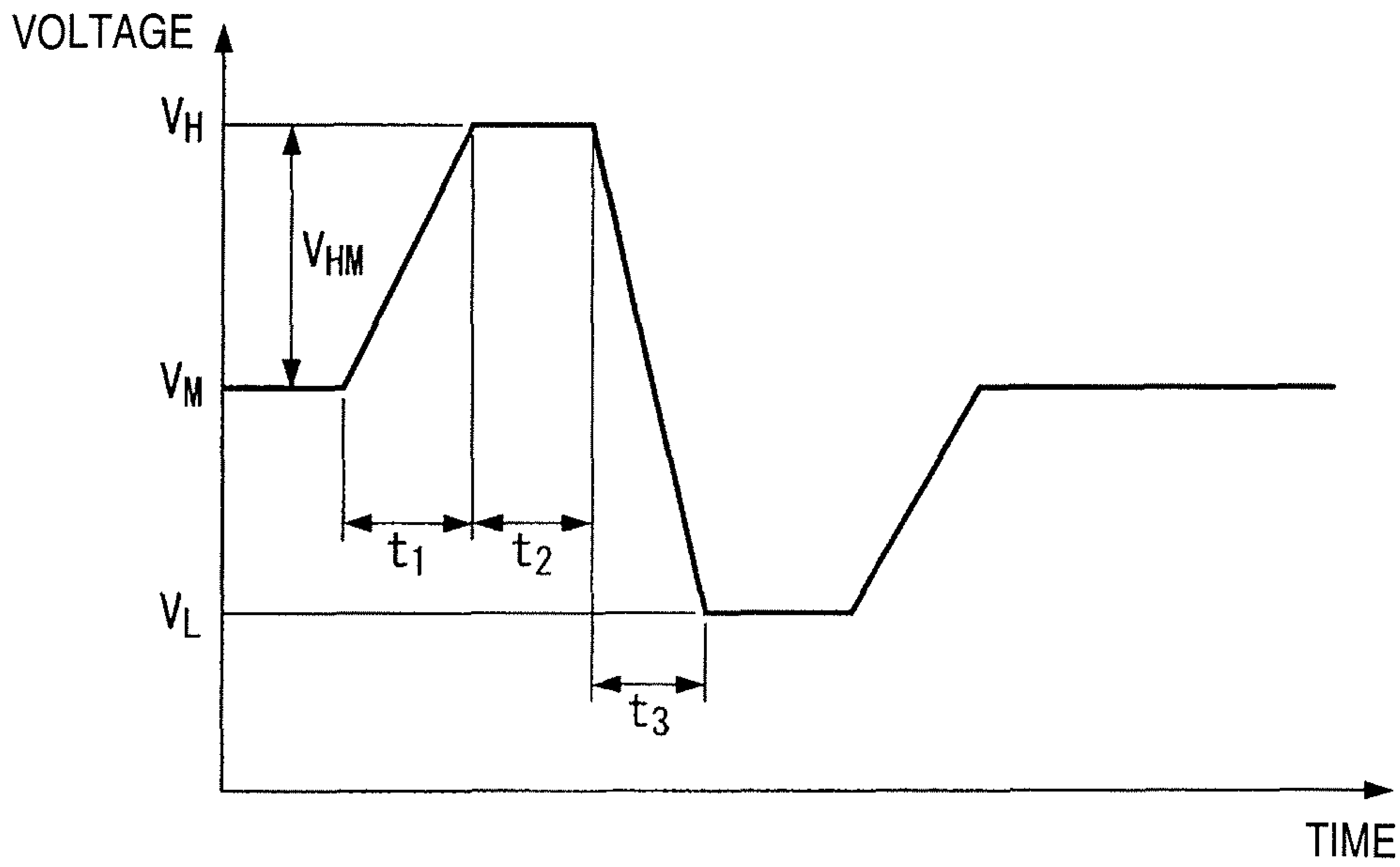
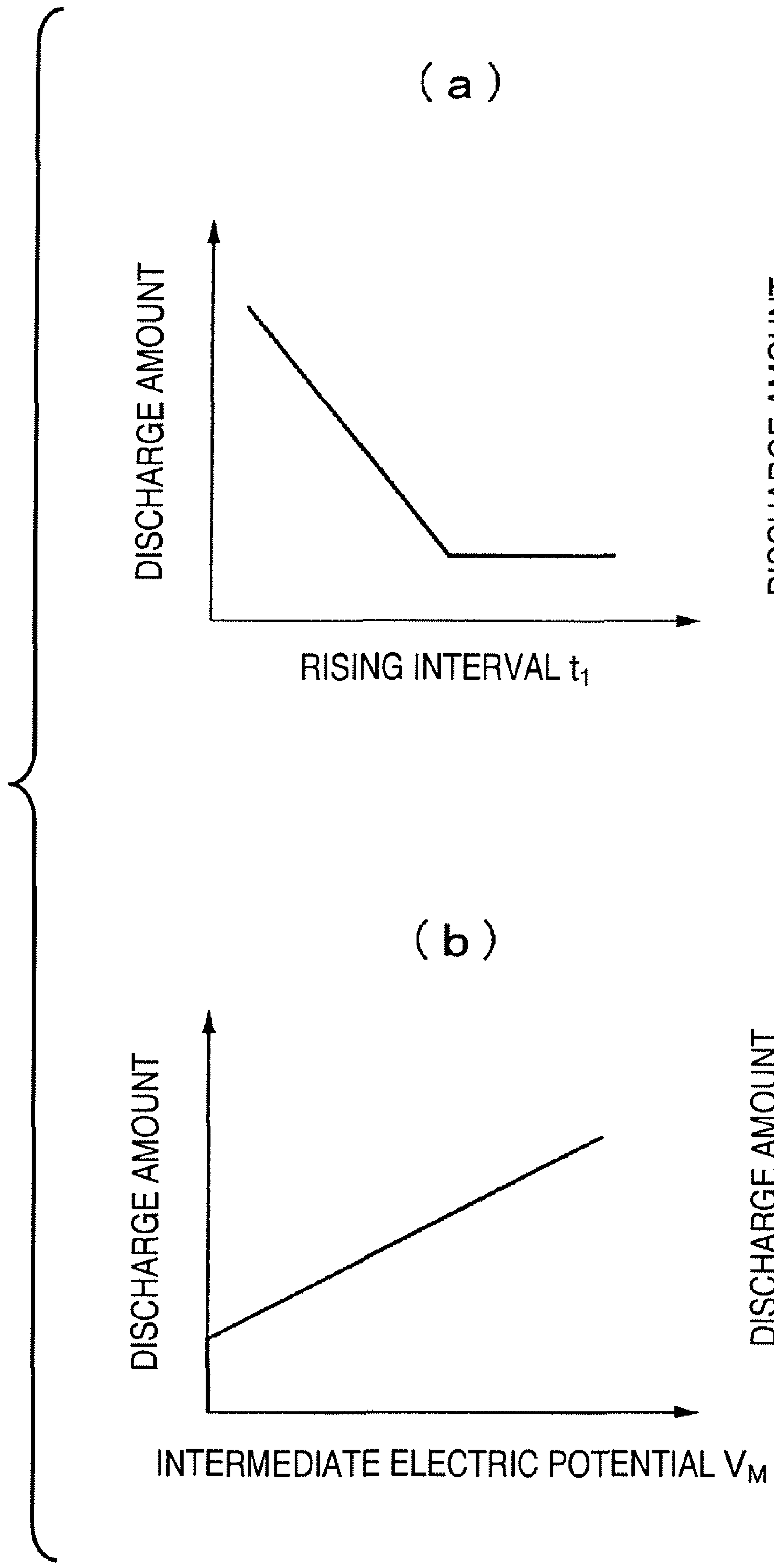
32
N1
L

FIG. 2



F I G. 3


(a)
DISCHARGE AMOUNT
RISING INTERVAL t_1
(c)
DISCHARGE AMOUNT
HOLDING INTERVAL t_2
(b)
DISCHARGE AMOUNT
INTERMEDIATE ELECTRIC POTENTIAL V_M
(d)
DISCHARGE AMOUNT
FALLING INTERVAL t_3

F I G. 4

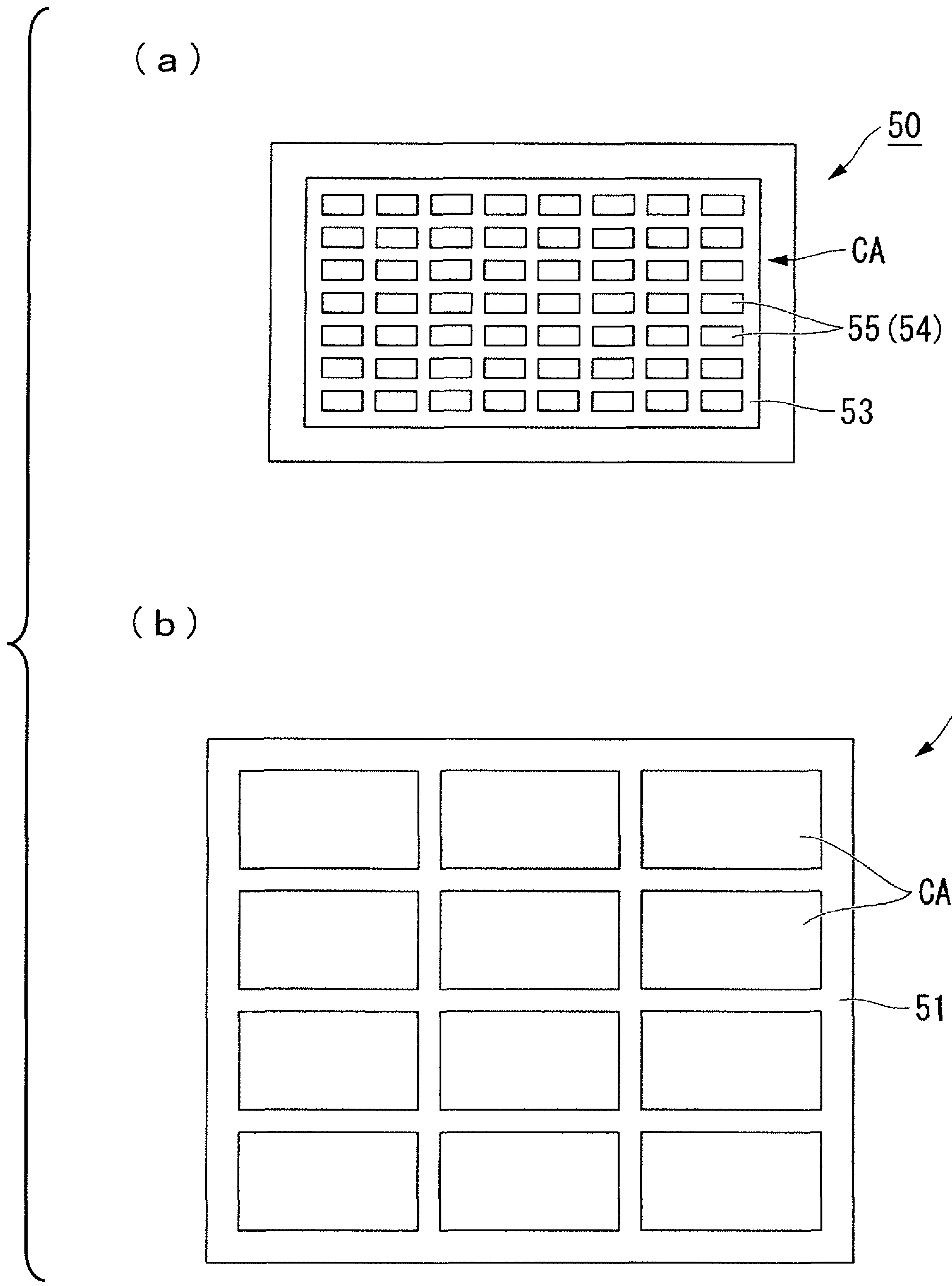
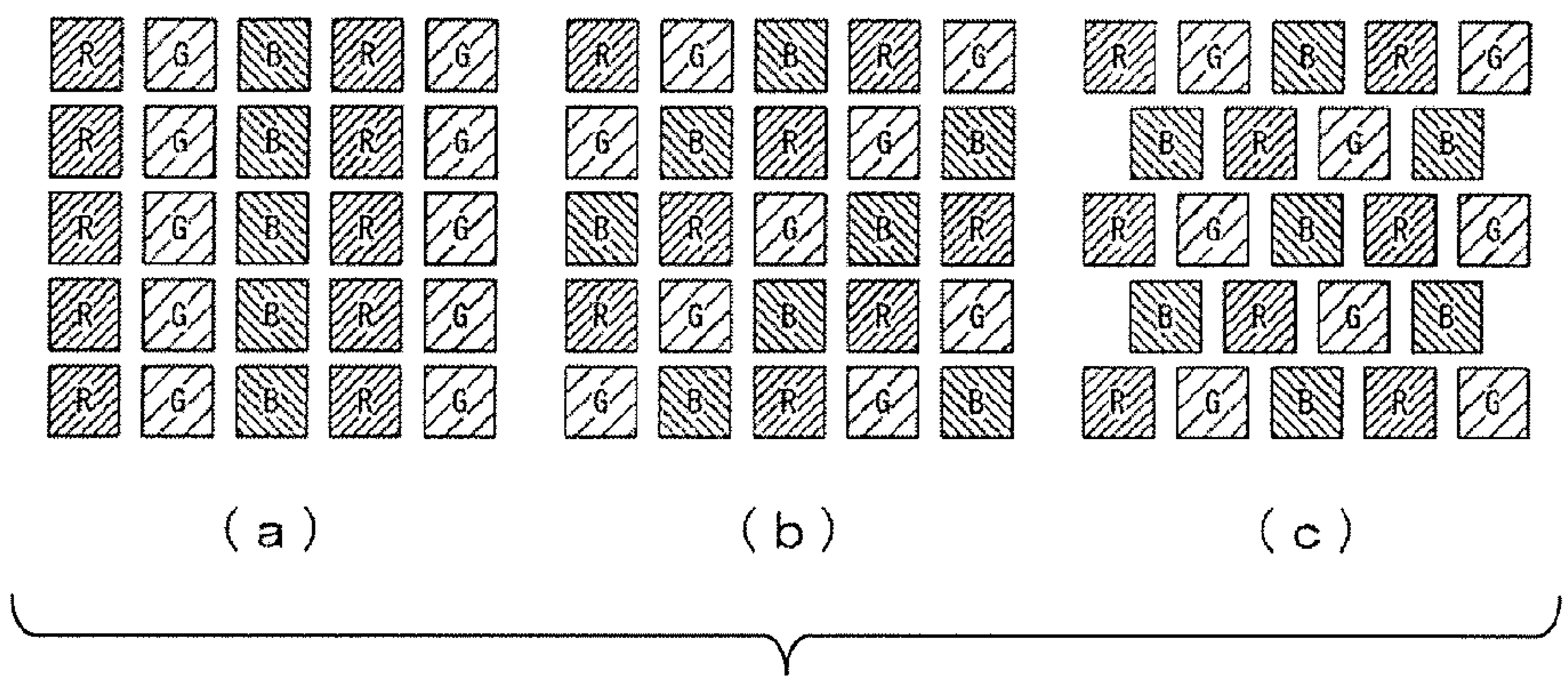
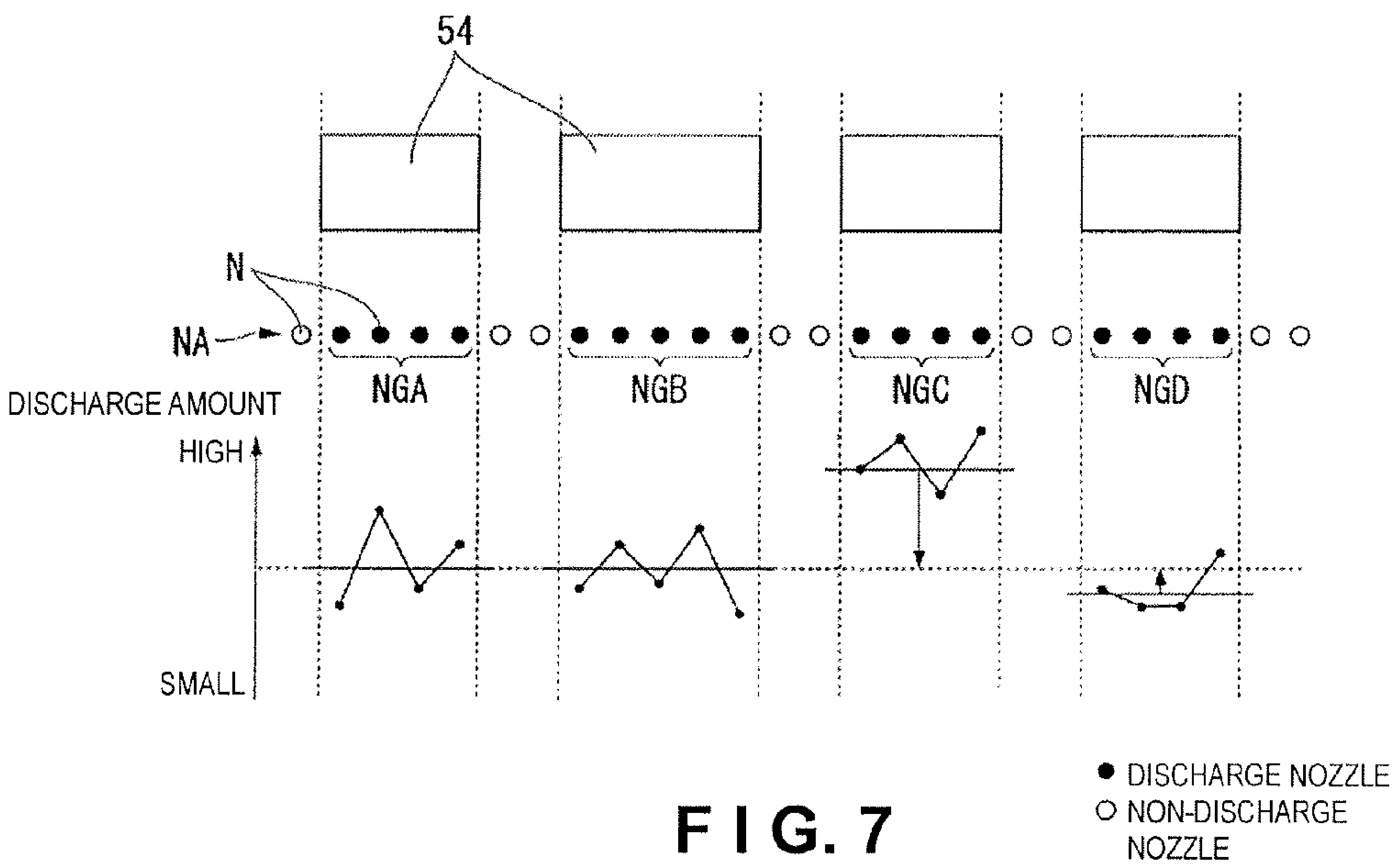


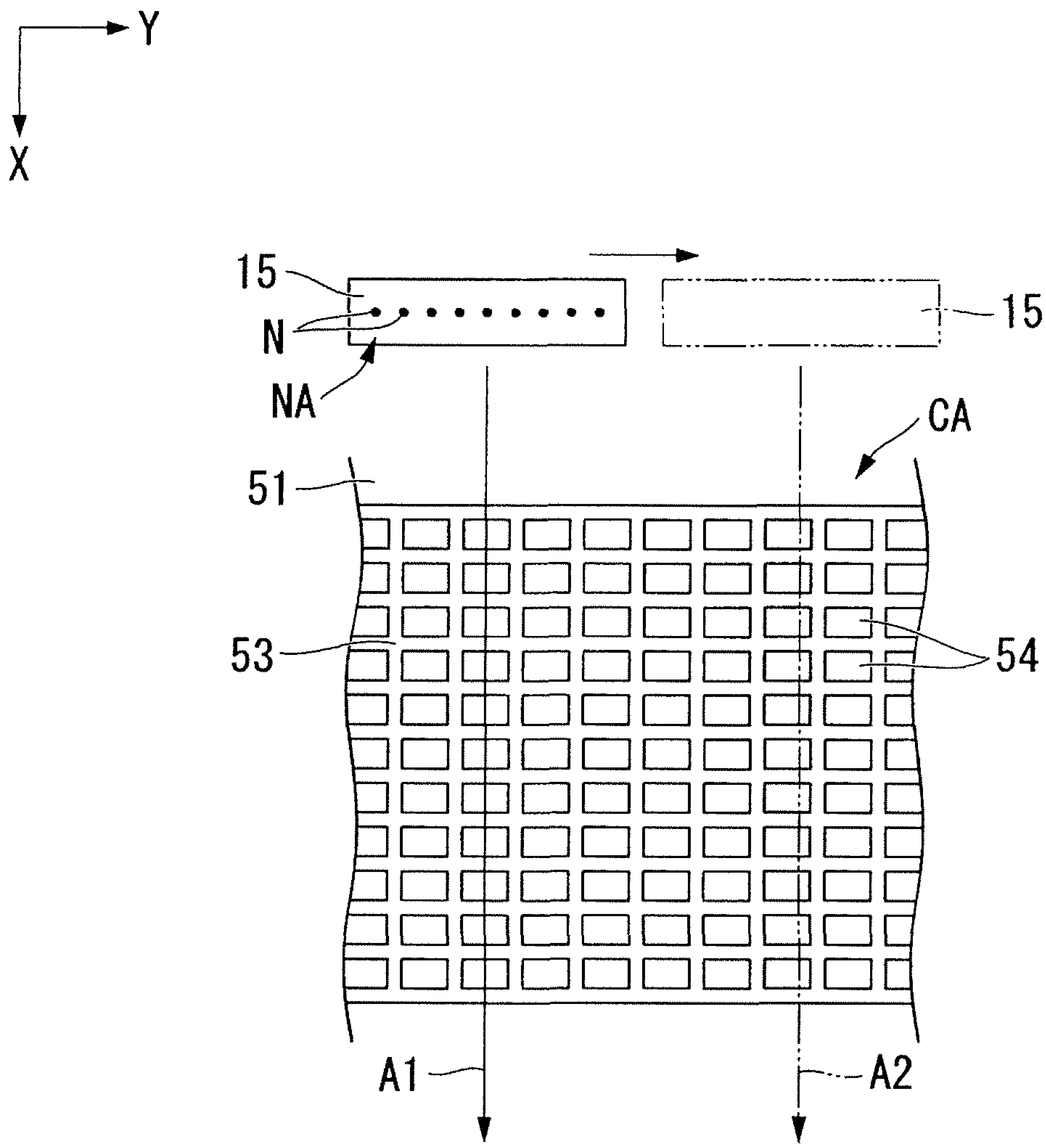
FIG. 5


R
G
B
(a)
(b)
(c)

F I G. 6


54
N
NA
NGA
NGB
NGC
NGD
DISCHARGE AMOUNT
HIGH
SMALL
● DISCHARGE NOZZLE
○ NON-DISCHARGE NOZZLE

F I G. 7



F I G. 8

DROPLET DISCHARGE METHOD AND DROPLET DISCHARGE DEVICE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to Japanese Patent Application No. 2009-127582 filed on May 27, 2009. The entire disclosure of Japanese Patent Application No. 2009-127582 is hereby incorporated herein by reference.

BACKGROUND

1. Technical Field

The present invention relates to a droplet discharge method and a droplet discharge device.

2. Related Art

In recent years, it has been proposed that color filters be manufactured using an inkjet method for discharging ink with a droplet discharge head (e.g., see Japanese Laid-Open Patent Application No. 11-248927). With this manufacturing method, liquid (droplets) containing a coloring material is discharged from a plurality of nozzles provided in the droplet discharge head that moves in a relative fashion in relation to a substrate to arrange (draw) the liquid, and the arranged liquid is dried or otherwise solidified to form a colored film that corresponds to a pixel.

In the manufacturing method that uses the inkjet method, there is a slight amount of variability in the discharge amount of the liquid from the plurality of nozzles. There are cases in which linear grayscale nonuniformity occurs in the color filter when the color filter is drawn with variability in the discharge amount of the liquid. Since such linear nonuniformity is readily visible, the quality of the image displayed via the color filter is reduced. In view of this situation, corrections are made to make the discharge amount of the liquid discharged from the nozzles uniform and reduce the nonuniformity of the discharge amount among the nozzles by adjusting the drive signals fed to the droplet discharge head.

SUMMARY

However, problems remain in the conventional droplet discharge method described above. Specifically, the amount of the liquid discharged from the nozzles is adjusted in a stepwise manner using drive signals fed to the droplet discharge head. Accordingly, the variability of the discharge amount of the liquid discharged from the nozzles cannot be made one-fourth or less than the variability prior to adjustment in the case the discharge amount of the liquid is adjusted in, e.g., four steps. It is therefore difficult to make the discharge amount of the liquid discharged from the nozzles perfectly uniform. A problem is thus presented in that linear grayscale nonuniformity still occurs.

The present invention was contrived in view of the prior art problems described above, and an object thereof is to provide a droplet discharge method and a droplet discharge device in which adjustment of the liquid discharge amount in the drawing regions is further facilitated.

A droplet discharge method according to a first aspect is a method for discharging a liquid into a plurality of drawing regions partitioned on a substrate from a plurality of nozzles formed in a droplet discharge head while moving the droplet discharge head relative to the substrate. The droplet discharge method includes dividing the nozzles into a plurality of nozzle groups so that the nozzles in one of the nozzles groups face the same drawing region, correcting an amount of the liquid discharged from the nozzles so that an average value of an amount of the liquid discharged from the nozzles constituting the nozzle groups is substantially uniform among the nozzle groups, and discharging the liquid from the nozzles while the droplet discharge head is moved relative to the substrate.

A droplet discharge device according to another aspect includes a droplet discharge head, a movement unit, and a correction unit. The droplet discharge head includes a plurality of nozzles configured and arranged to discharge droplets of a liquid into a plurality of drawing regions partitioned on a substrate. The movement unit is configured and arranged to move the droplet discharge head relative to the substrate. The correction unit is configured to divide the nozzles into a plurality of nozzle groups so that the nozzles in one of the nozzles groups face the same drawing region, and to correct an amount of the liquid discharged from the nozzles so that an average value of an amount of the liquid discharged from the nozzles constituting the nozzle groups is substantially uniform among the nozzle groups.

According to these aspects, control of the discharge amount in the drawing regions is further facilitated by correcting the average value of the discharge amounts in each nozzle group. Specifically, the height of the liquid level of the liquid discharged into the drawing regions is made uniform by making the average value of the discharge amounts of the nozzles constituting one nozzle group equivalent to the average value of the discharge amounts of the nozzles constituting the other nozzle groups. Thus, even when the amount of the liquid discharged from one nozzle constituting the nozzle group is considerable, the average value of the discharge amounts for the nozzle groups overall can be set to a desired value by reducing the discharge amounts of the liquid discharged from other nozzles. Accordingly, the average value of the discharge amounts can be more finely corrected for the nozzle groups overall in comparison with the case in which the discharge amounts of the nozzles are corrected to achieve a predetermined value. Therefore, the height of the liquid level of the liquid discharged in the drawing regions is more uniform and the occurrence of linear grayscale nonuniformity can be more reliably reduced.

The droplet discharge method may correct the amount of the liquid discharged from each of the nozzles in a stepwise manner.

The droplet discharge device may be configured so that the correction unit is configured to correct the amount of the liquid discharged from each of the nozzles in a stepwise manner.

According to these aspects, the average values of the discharge amounts of the liquid discharged from the nozzles in each nozzle group are corrected so as to yield a predetermined amount by correcting the amounts of liquid discharged from the nozzles in a stepwise manner. Accordingly, the average value of the discharge amounts of the nozzle groups overall can be finely corrected, even when the discharge amounts of the liquid discharged from the nozzles cannot be finely corrected in a stepwise manner.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring now to the attached drawings which form a part of this original disclosure:

FIG. **1** is a perspective view showing the droplet discharge device in an embodiment of the present invention;

FIG. **2** includes a series of diagrams showing the configuration of a droplet discharge head;

FIG. **3** is a diagram showing the waveform of the drive signal;

FIG. **4** includes diagrams (a) to (d) for showing the relationship between the waveform of the drive signal and the discharge amount of the liquid;

FIG. **5** includes schematic plan views showing the color filter and the color filter substrate;

FIG. **6** includes plan views showing the arrangement of the color filter layer;

FIG. **7** is a descriptive view for illustrating the droplet discharge method; and

FIG. **8** is a schematic plan view for illustrating the droplet discharge method.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

An embodiment of the droplet discharge method and droplet discharge device of the present invention is described below with reference to the drawings. In the drawings used in the following description, the reduced scale is suitably varied in order to allow the members to be recognized.

Droplet Discharge Device

First, the droplet discharge device of the present embodiment will be described.

The droplet discharge device **1** is a device for discharging liquid in predetermined regions of a later-described mother substrate (substrate) **51** using, e.g., an inkjet method to form a color filter layer **55** (described further below), as shown in FIG. **1**. The droplet discharge device **1** is provided with a device trestle **11**, a work stage **12**, a stage movement device (movement mechanism) **13**, a carriage **14**, droplet discharge heads **15**, a carriage movement device (movement device) **16**, a tube **17**, first through third tanks **18** to **20**, and a control device **21**. At least one of the stage movement device **13** and the carriage movement device **16** constitutes a movement unit of the present embodiment.

The device trestle **11** is a support platform for the work stage **12** and the stage movement device **13**. The work stage **12** is arranged in the X direction, which is the primary scan direction, on the device trestle **11** so that the work stage **12** can be moved by the stage movement device **13**, and the mother substrate **51** transported from an upstream transport device (not shown) is held on the XY plane by a chucking mechanism.

The stage movement device **13** is provided with a linear guide and ball screw, or another direct drive mechanism, and the work stage **12** is moved in the X direction the basis of a stage position control signal that indicates the X coordinate of the movement destination of the work stage **12** inputted from the control device.

The carriage **14** holds the droplet discharge heads **15** and is provided so that the carriage movement device **16** can move the carriage **14** in the Z direction and the Y direction, which is the secondary scan direction.

The droplet discharge heads **15** are provided in corresponding fashion to R (red), G (green), and B (blue) liquid, and are connected to respective tubes **17** via the carriage **14**.

R (red) liquid is fed from a first tank **18** to the droplet discharge head **15** that corresponds to R (red) via the tube **17**, G (green) liquid is fed from a second tank **19** to the droplet discharge head **15** that corresponds to G (green) via the tube **17**, and B (blue) liquid is fed from a third tank **20** to the droplet discharge head **15** that corresponds to B (blue) via the tube **17**.

The droplet discharge heads **15** are provided with a plurality (e.g., 180) of nozzles N_1 to N_{180} (may hereinafter be generically referred to as "nozzles N") arrayed in equidistant intervals in the Y direction, as shown in FIG. **2**(*a*). These nozzles N_1 to N_{180} formed into nozzle rows NA.

The droplet discharge heads **15** are provided with only a single nozzle row NA, but a plurality of rows may provided, and the number of nozzles N constituting the nozzle rows NA is not limited to 180. The number of droplet discharge heads **15** arranged in the carriage **14** can be modified as required. A plurality of carriages **14** may furthermore be provided in sub-carriage units.

Since there is considerable variability in the liquid discharge amounts for the nozzles at the two ends among the plurality of nozzles N_1 to N_{180} (e.g., nozzles N_1 to N_9 and nozzles N_{171} to N_{180}), there may be cases in which such are not used for discharging liquid.

The droplet discharge heads **15** are provided with vibration plate **31** having a material feed hole **31***a* connected to the tube **17**, a nozzle plate **32** in which the nozzles N_1 to N_{180} are provided, a reservoir **33** provided between the vibration plate **31** and the nozzle plate **32**, a plurality of partition walls **34**, and a plurality of liquid retaining portions **35**, as shown in FIG. **2**(*b*).

Drive elements PZ_1 to PZ_N (may hereinafter be generically referred to as "drive elements PZ") are arranged on the vibration plate **31** in correspondence to the nozzles N_1 to N_{180}. The drive elements PZ are, e.g., piezoelements.

The reservoir **33** is designed to be filled with a liquid fed via the material feed hole **31***a*.

The liquid retaining portions **35** are formed by being enclosed by the vibration plate **31**, the nozzle plate **32**, and a pair of partition walls **34**. The liquid retaining portions **35** are formed in a one-to-one correspondence to the nozzles N_1 to N_M. The liquid is introduced from the reservoir **33** via a feed port **35***a* provided between the pair of partition walls **34**.

A single drive element PZ is provided with a piezoelectric material **36** and a pair of electrodes **37** that hold the piezoelectric material therebetween, as shown in FIG. **2**(*c*). The drive element PZ is configured to cause the piezoelectric material **36** to contract when a drive signal is applied between the pair of electrodes **37**, and the vibration plate **31** is simultaneously caused to flex outward (the side opposite from the liquid-retaining portion **35**) together with the drive element PZ due to the contraction of the piezoelectric material **36** to increase the volume of the liquid-retaining portion **35**.

Therefore, the liquid flows in to the reservoir **33** via the feed port **35***a* in an amount that corresponds to the increased volume inside the liquid-retaining portion **35**. When the drive signal applied to the drive element PZ is stopped in such a state, the drive element PZ and the vibration plate **31** return to their former shapes, and the liquid-retaining portion **35** also returns to its original volume. The pressure of the liquid inside the liquid-retaining portion **35** is thereby increased, and a droplet L of the liquid is discharged from the nozzle N_1 toward the mother substrate **51**.

The carriage movement device **16** forms a bridge structure that straddles the device trestle **11**, as shown in FIG. **1**, and is provided with a linear guide and ball screw, or another direct drive mechanism along the Y and Z directions. The carriage **14** is moved in the Y and Z directions on the basis of a carriage position control signal that indicates the Y and Z coordinates of the movement destination of the carriage **14** inputted from the control device **21**.

The tubes **17** are used for feeding the liquid and provide a connection between the carriage **14** and the first through third tanks **18** to **20**.

The first tank **18** stores the liquid for R (red) and feeds the liquid to the droplet discharge head **15** that corresponds to R (red) via the tube **17**. The second tank **19** stores the liquid for G (green) and feeds the liquid to the droplet discharge head **15** that corresponds to G (green) via the tube **17**. The third tank **20** stores the liquid for B (blue) and feeds the liquid to the droplet discharge head **15** that corresponds to B (blue) via the tube **17**.

The control device **21** is provided with a scan controller **41** for controlling the scanning of the droplet discharge heads **15**, and a discharge controller (correction unit) **42** for controlling the discharge of the liquid from the nozzles N.

The scan controller **41** controls the operation for positioning the mother substrate **51** by moving the work stage **12**, and the scan controller **41** for controlling the operation for positioning the droplet discharge heads **15** by moving the carriage **14**. The scan controller **41** outputs a stage position control signal to the stage movement device **13**, and positions the mother substrate **51**; and outputs a carriage position control signal to the carriage movement device **16** and positions the droplet discharge heads **15**.

The discharge controller **42** outputs drawing data and a drive signal to the droplet discharge heads **15** and causes the liquid to be discharged from the nozzles N. The discharge controller **42** feeds four types of drive signals to the drive elements PZ that correspond to the nozzles N, and controls the discharge amounts from the nozzles N in four steps. Here, variability occurs in the discharge amounts of the liquid discharged from the nozzles N when the same drive signal is fed to the drive elements PZ that correspond to the nozzles N to cause the liquid to be discharged. In view of the above, the discharge controller **42** groups the plurality of nozzles N for each plurality of nozzles N positioned above the same later-described drawing region **54** into a plurality of nozzle groups NG (nozzle groups NGA to NGD; see FIG. **7**). The drive signal is selected and fed to the drive elements PZ so that the average value of the discharge amounts of the liquid discharged from the plurality of nozzles N constituting the nozzle groups NG achieves a predetermined value.

Specifically, the discharge controller **42** corrects the discharge amounts of the liquid from the nozzles N using the voltage component in a drive signal having a waveform such as that shown in FIG. **3**.

During the rise interval t_1 in FIG. **3**, the volume of the liquid-retaining portion **35** adjacent to the nozzles N increases and the liquid is fed into the liquid-retaining portion **35**. Here, the position of the meniscus is moved to the liquid-retaining portion **35** side due to the increased the volume of the liquid-retaining portion **35** during the rise interval t_1. This movement distance increases as the length of the rising interval t_1 is reduced. This is due to the fact that the meniscus is drawn into the liquid-retaining portion **35** with greater force as the rising interval t_1 is reduced in length. Accordingly, the meniscus is considerably moved to the liquid-retaining portion **35** side and the discharge amount of the liquid can be reduced by an amount commensurate with the distance that the meniscus is drawn inward by directly and rapidly transitioning to the discharge operation, as shown in FIG. **4**(*a*). Conversely, when the rising interval t_1 is increased and the distance the meniscus moves toward the liquid-retaining portion **35** side is reduced, the discharge amount of the liquid is increased by an amount commensurate with the distance that the meniscus is drawn inward by a reduced distance.

The electric potential V_M (intermediate electric potential) prior to rising affects the movement distance of the meniscus. When the intermediate electric potential V_M is brought close to the electric potential V_H in a charging state and the electric potential difference V_{HM} is reduced, the meniscus substantially does not move even when the rising interval t_1 is shortened, as shown in FIG. **4**(*b*). Accordingly, the amount of the liquid discharged substantially does not change even when a rapid transition is made to the discharge operation. On the other hand, when the electric potential difference V_{HM} is increased, the distance the meniscus moves is increased. Therefore, the discharge mount is reduced by an amount equivalent to the distance that the meniscus is drawn inward when a transition is rapidly made to the discharge operation.

When the volume change of the liquid-retaining portion **35** ends, the meniscus thus drawn inward to the liquid-retaining portion **35** side attempts to return to its original position, and the meniscus vibrates based on the original position. Accordingly, when a transition to the discharge operation is made at the time that the meniscus has vibrated to the liquid-retaining portion **35** side, the discharge amount is reduced by an amount equivalent to the distance that the meniscus is drawn inward. On the other hand, when a transition to the discharge operation is made at the time that the meniscus has vibrated to the opposite side of the liquid-retaining portion **35**, the discharge amount is increased by an amount equivalent to the distance that the meniscus considerably extends outward. Therefore, the discharge amount reflects periodic fluctuation in which it increases or decreases repeatedly in accompaniment with the increase in the holding interval t_2, as shown in FIG. **4**(*c*).

The falling interval t_3 in FIG. **3** affects the applied pressure when the liquid is pressed from the nozzles N to the exterior. When the falling interval t_3 is short, the applied pressure is increased; and when the falling interval t_3 is long, the applied pressure is reduced. When the applied pressure is high, the discharge amount is increased in a commensurate fashion because the liquid flies out from the nozzles N with good force, as shown in FIG. **4**(*d*). Conversely, when the applied pressure is low, the discharge amount is reduced in a commensurate fashion because the liquid is slowly pressed out.

As described above, the discharge amount of the liquid can be corrected by making use of the fluctuations in the discharge amount caused by the behavior of the meniscus and by controlling the drive signals. In the present embodiment, the discharge amount of the liquid is corrected by varying the intermediate electric potential V_M in a stepwise manner using the steps of the drive signal. The discharge amount of the liquid may be corrected by varying other conditions in a stepwise manner using the steps of the drive signal.

Color Filter

Next, the color filter manufactured using the droplet discharge device **1** configured in the manner described above will be described.

A color filter **50** is manufactured by dividing a color filter substrate **52** into a plurality of panel regions CA, the panel regions CA being provided on a large-surface-area mother substrate **51** made of glass, a plastic material, or the like, as shown in FIGS. **5**(*a*) and **5**(*b*).

The panel regions CA are arranged in the form of a matrix and have a plurality of drawing regions **54** partitioned by a bank **53**. The drawing regions **54** are arranged in the form of a matrix and have a color filter layer **55** formed therein.

The array of color filter layers **55** has the same color in one direction, and in the orthogonal direction, colors are repeated in the sequence of R (red), G (green), and B (blue). In other words, the color filter layers **55** are disposed in a striped arrangement in which the color filter layers **55** of the same color provided in a linear fashion in a single direction are arranged in alternating fashion in the orthogonal direction.

The arrangement of the color filter layers **55** is not limited to the striped arrangement shown in FIG. **6**(*a*); it is also possible to use a mosaic arrangement such as that shown in FIG. **6**(*b*), a delta-shaped arrangement such as that shown in FIG. **6**(*c*), or another arrangement.

Droplet Discharge Method

The method for discharging droplets using the droplet discharge device **1** configured in the manner described above will be described next. In the present embodiment, a color filter is manufactured using the droplet discharge method.

First, the mother substrate **51** on which banks **53** have been formed is mounted on the work stage **12**, and the upper surface of the mother substrate **51** and the droplet discharge heads **15** are disposed opposite each other, as shown in FIG. **1**.

The liquid is discharged toward the drawing regions **54** from the plurality of nozzles N of the droplet discharge heads **15** (scan step) while the stage movement device **13** and the carriage movement device **16** are moved (scanned) relative to the mother substrate **51**. In this situation, the droplet discharge heads **15** discharge the liquid onto the drawing regions **54** partitioned on the mother substrate **51** while the droplet discharge heads **15** are moved relative to the mother substrate **51** along the direction of the arrow A**1**, which is the primary scan direction, as shown in FIG. **8**.

Since each of the drawing regions **54** is arranged in the form of a matrix on the mother substrate **51**, the liquid is not discharged in a simultaneous fashion from all of the nozzles N in the droplet discharge heads **15**. Accordingly, among the plurality of nozzles N, there are nozzles N (discharge nozzles) that discharge the liquid when positioned above the drawing region **54** and there are nozzles N (non-discharge nozzles) that do not discharge the liquid when not positioned over the drawing region **54**, as shown in FIG. **7**. The discharge controller **42** groups (grouping step) the plurality of nozzles N into nozzle groups NG for each nozzle N positioned above the same drawing region **54**.

In this present embodiment, variability occurs in the discharge amounts of the nozzles N, as shown in FIG. **7**. In other words, the average value of the discharge amounts of the liquid discharged from the nozzles N constituting the nozzle group NGA is substantially the same as the average value of the discharge amounts in the nozzle group NGB, but the average value of the discharge amounts in the nozzle group NGC is high and the average value of the discharge amounts in the nozzle group NGD is low.

In view of the above, the discharge controller **42** selects the drive signal to be fed to the drive elements PZ that correspond to the nozzles N so that the average value of the discharge amounts of the liquid discharged from the nozzles constituting the nozzle groups NG are uniform at a predetermined amount in the nozzle groups NG. In other words, the discharge controller **42** selects from among four gradations the drive signal to be fed to the drive elements PZ that correspond to the nozzles N constituting the nozzle group NGC, and the average value of the discharge amount of the liquid discharged from the nozzles N constituting the nozzle group NGC is reduced. Also, the discharge controller **42** similarly increases the average value of the discharge amounts of the liquid discharged from the nozzles N constituting the nozzle group NGD.

Corrections are thus made in the nozzle groups NG so that the average value of the amounts of the liquid discharged from the nozzles N constituting the nozzle groups NG reaches a predetermined amount. The discharge controller **42** may correct the discharge amount of a portion of the plurality of nozzles N constituting the nozzle groups NG, or may correct the discharge amount for all the plurality of nozzles N constituting the nozzle groups NG.

Making corrections so that the average value of the discharge amounts of the liquid discharged from the nozzles N in the nozzle groups NG reaches a predetermined value thus makes the height of the liquid level formed by the liquid discharged into the drawing region **54** uniform.

Thereafter, the droplet discharge heads **15** are moved a predetermined distance in a relative fashion in the Y direction, which is the secondary scan direction, and then moved again in a relative fashion along the direction of the arrow A**2**, which is the primary scan direction. At this point, the discharge controller **42** regroups the plurality of nozzles N and corrects the discharge amounts of the liquid discharged from the nozzles N in the same manner as described above. In this situation, the color filter layer **55** is formed with reduced linear grayscale nonuniformity because the height of the liquid level of the liquid is uniform in the drawing regions **54**.

The droplet discharge heads **15** are arranged along the Y direction, which is the secondary scan direction, but may also be arranged in a diagonally sloping direction with respect to the Y direction so that the pitch of the nozzles N and the pitch of the drawing regions **54** are in a predetermined correspondence relationship. The average value of the discharge amounts may be substantially uniform among the plurality of nozzle groups NG.

The color filter substrate **52** is manufactured in the manner described above. Thereafter, the mother substrate **51** is divided into panel regions CA to manufacture individual color filters **50**.

As described above, in the droplet discharge method and droplet discharge device **1** of the present embodiment, the average value of the discharge amounts in the nozzles N constituting a single nozzle group NG is made equivalent to the average value of the discharge amounts in the nozzles N constituting the other nozzle groups NG, whereby the variability in the average value of the discharge amounts can be reduced to ¼ or less for the nozzle groups NG overall, even when the discharge amounts of the liquid are corrected in a stepwise manner in four steps. Accordingly, the average value of the discharge amounts can be more finely corrected for the nozzle groups NG overall in comparison with the case in which the discharge amounts are made uniform for all nozzles N. Therefore, the height of the liquid level of the liquid discharged into the drawing regions **54** becomes more uniform, and the occurrence of linear grayscale nonuniformity can be more reliably reduced.

The present invention is not limited to the embodiment described above, and various modifications can be made within range that does not depart from the spirit of the present invention.

For example, the discharge controller uses four steps to make corrections to the discharge amounts of the liquid discharged from the nozzles, but the corrections can be made in at least two steps, and the corrections can be made in multiple steps.

The droplet discharge device and the droplet discharge method are used for forming a color filter layer in a color filter, but other applications are possible as long as a thin film is formed by discharging a liquid into predetermined regions on a substrate, e.g., the formation of layers constituting a light-emitting layer in an organic EL device.

The movement mechanism is composed of a stage movement device and a carriage movement device, but also possible are configurations in which the carriage movement device is capable of moving in the XY plane, as well as other configurations, as long as the droplet discharge heads can be moved relative to the mother substrate.

General Interpretation of Terms

In understanding the scope of the present invention, the term "comprising" and its derivatives, as used herein, are intended to be open ended terms that specify the presence of the stated features, elements, components, groups, integers, and/or steps, but do not exclude the presence of other unstated features, elements, components, groups, integers and/or steps. The foregoing also applies to words having similar meanings such as the terms, "including", "having" and their derivatives. Also, the terms "part," "section," "portion," "member" or "element" when used in the singular can have the dual meaning of a single part or a plurality of parts. Finally, terms of degree such as "substantially", "about" and "approximately" as used herein mean a reasonable amount of deviation of the modified term such that the end result is not significantly changed. For example, these terms can be construed as including a deviation of at least ±5% of the modified term if this deviation would not negate the meaning of the word it modifies.

While only selected embodiments have been chosen to illustrate the present invention, it will be apparent to those skilled in the art from this disclosure that various changes and modifications can be made herein without departing from the scope of the invention as defined in the appended claims. Furthermore, the foregoing descriptions of the embodiments according to the present invention are provided for illustration only, and not for the purpose of limiting the invention as defined by the appended claims and their equivalents.

What is claimed is:

1. A droplet discharge method for discharging a liquid into a plurality of drawing regions partitioned on a substrate from a plurality of nozzles formed in a droplet discharge head while moving the droplet discharge head relative to the substrate, the droplet discharge method comprising:

discharging the liquid from the nozzles while the droplet discharge head is moved relative to the substrate, the nozzles including first nozzles and a second nozzle that are arranged so that the first nozzles face the drawing regions, and so that the second nozzle faces a non-discharge area, the non-discharge area being disposed between the drawing regions;

dividing only the first nozzles into a plurality of nozzle groups so that the nozzles in one of the groups face the same drawing region;

comparing an average value of an amount of the liquid discharged from the nozzles constituting each of the nozzle groups with a predetermined average value; and

increasing the average value such that the average value is substantially equal to the predetermined average value when the average value is lower than the predetermined average value, or decreasing the average value such that the average value is substantially equal to the predetermined average value when the average value is higher than the predetermined average value, by correcting an amount of the liquid discharged from each of the nozzles in each of the nozzle groups.

2. The droplet discharge method according to claim **1**, wherein

the correcting of the amount of the liquid discharged from the nozzles includes correcting the amount of the liquid discharged from each of the nozzles in a stepwise manner.

3. The droplet discharge method according to claim **2**, wherein

the amount of the liquid discharged from each of the nozzles is corrected in the stepwise manner by changing an intermediate electric potential of a drive signal applied to each of the nozzles, and the intermediate electric potential is a potential prior to rising to a highest electric potential of the drive signal in a charging state and higher than a lowest electric potential of the drive signal.

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